SURFACE DRAINAGE, MAIN OR LATERAL

(Feet)

Code 608

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

An open drainage ditch constructed to a designed size and grade.

II. Purpose

To dispose of excess surface or subsurface water, intercept ground water, control ground water levels, provide for leaching of saline or alkali soils, or a combination of these objectives.

III. Conditions Where Practice Applies

This practice applies on lands to be drained where an outlet for the drainage system will be available, either by gravity flow or by pumping.

This practice does not apply to field ditches for the disposal of surface water. These shall be in accordance with the criteria in NRCS Field Office Technical Guide (FOTG) Section IV, Standard 607, Surface Drainage, Field Ditch.

This practice also does not apply to mains or laterals having a drainage area of more than 1 square mile. These shall meet the requirements of FOTG Standard 582, Open Channel.

IV. Federal, State, and Local Laws

Users of this standard should be aware of potentially applicable federal, state, and local laws, rules, regulations, or permit requirements governing surface drainage, main or lateral. This standard does not contain the text of federal, state, or local laws.

V. Criteria

The following criteria apply to all purposes.

A. General

An adequate soil investigation shall be made to determine critical sections with regard to velocity limitations. Soil samples shall be obtained and tested, as needed, to provide design parameters.

B. Drainage Requirements

Mains and laterals shall be located and designed to serve as integral parts of a surface or subsurface drainage system that meets the conservation and land use needs. The degree of drainage required by the crops shall be determined and expressed in terms of drainage coefficients or depth and spacing of drains.

C. Capacity

The ditch capacity shall be adequate to provide for the removal of excess water, based on climatic and soil conditions and the needs of crops. The required capacity shall be obtained by determining the watershed area; the required topographic, soil, and land use information; and use of the appropriate drainage coefficient curves.

Minimum drainage curves shall be as shown in Figure 1.

The drainage curve designated for each county is applicable to areas with average watershed slopes of less than 25 feet per mile. For lands with steeper slopes, the next higher runoff drainage curve shall be used.

Design flow for the selected drainage curve will be determined from Chapter 14 of the NRCS National Engineering Handbook (NEH), Part 650, Engineering Field Handbook.

Guidelines for depth and spacing of the open ditches used for internal drainage or water table control are contained in the NRCS Drainage Guide for Wisconsin.

D. Capacity Design

Manning's Formula shall be used in determining the design velocity, and the value of "n" shall be based on alignment, probable vegetative growth expected with normal maintenance, other roughness factors, and the hydraulic radius. Unless special site studies are available to justify

other values, the following values of Manning's "n", based on the hydraulic radius of the channel and assuming an aged channel with good maintenance and good alignment, shall be used in solving Manning's equation for mains and laterals when determining the design for required capacity.

Table 1
Manning's "n" Values

Hydraulic Radius	Manning's "n"
Less than 2.5	.040 to .045
2.4 to 4.0	.035 to .040
4.1 to 5.0	.030 to .035
More than 5.0	.025 to .030

E. Hydraulic Gradeline

The hydraulic gradeline for drainage ditch design shall be determined from control points, including elevations of significant low area served by the ditch and hydraulic gradeline of any tributary ditches and the outlet. If control point elevations are estimated rather than computed from survey data, the hydraulic gradeline shall be no less than:

- 1 foot below fields that will receive normal drainage from ditches draining more than 1 square mile.
- 0.5 feet for ditches draining 40 to 640 acres.
- 0.3 feet for ditches draining less than 40 acres.

For lands to be used only for water-tolerant crops, such as trees and grasses, these requirements may be modified and the hydraulic gradeline set at ground level. These provisions do not apply to channels where flow is contained by dikes.

The effects of hydraulic losses caused by culverts, bridges, or other obstructions in the channel section shall be taken into account.

F. Depth

Drainage ditches shall be designed deep enough to allow for normal siltation. If needed, the design depth and capacity may be increased to provide adequate subsurface drainage or for normal flow. The increase shall be based on an evaluation of site conditions.

Ditches that serve as outlets for subsurface drains shall be designed for a normal water surface at or below the invert of the outlet end of the drain. The clearance between a drain invert and the ditch bottom shall be at least 1 foot for ditches that fill with sediment at a normal rate, except where lower values are specified for a job because of unusual site conditions. The normal water surface is the elevation of the usual low flow during the growing season.

G. Cross Section

The design ditch cross section shall be set below the design hydraulic gradeline and shall meet the combined requirements of capacity, limiting velocity, depth, side slopes, bottom width, and, if needed, allowances for initial sedimentation.

The minimum bottom width shall be 4 feet. Side slopes shall be stable, shall meet maintenance requirements, and shall be designed on the basis of on-site conditions, but no steeper than 2:1 (2 horizontal to vertical) in mineral soils or 1:1 in organic soils.

H. Velocity

A desirable minimum velocity is 1.5 feet/second. On flat grades, a channel cross section shall be selected on the basis of the depth and maintenance requirements, which will result in the desirable minimum velocity if possible.

The maximum permissible design velocity shall be based on site conditions and shall insure stability of the ditch bottom and side slopes.

Maximum channel velocities shall be according to Table 2.

Table 2
Permissible Bare Earth Velocities

Soil Texture	Maximum Velocity feet/second
Sandy and sandy loam	2.5
Silt loam	3.0
Sandy clay loam	3.5
Clay loam	4.0
Stiff clay, fine gravel, graded loam to gravel	5.0

The design velocity shall be based on the smaller of:

- bankfull flow,
- the design discharge,
- the 10-year frequency, 24 hour duration flow.

The velocity for newly constructed channels with drainage areas in excess of 1 square mile shall meet the stability requirements specified for NRCS FOTG Standard 582, Open Channel.

I. Berms and Spoil Banks

Adequate berms shall be provided and shaped, as required, to provide access for maintenance equipment, to eliminate the need for moving spoil banks in future operations, to provide for work areas and facilitate spoilbank spreading, to prevent excavated material from washing or rolling back into ditches, and to lessen sloughing of ditchbanks caused by heavy loads too near the edge of the ditchbanks. The following minimum berm widths shall be provided, except where spoil is spread:

Table 3
Berm Width

Ditch Depth in Feet	Minimum Berm Width in Feet
2 to 6	8
6 to 8	10
More than 8	15

In organic or unstable soils, the berm width shall be increased accordingly to provide bank stability.

Spoil not utilized for berms shall be spread, utilized, or removed from the site as soon as practical. Spreading shall meet the requirements of NRCS FOTG Standard 572, Spoil Spreading.

If spoil material is to be placed in banks along the ditch rather than spread over adjacent fields, the spoilbanks shall have stable side slopes. Provision must be made to channel water through the spoil and into the ditch without causing serious erosion.

J. Related Structures and Ditch Protection

Mains and laterals shall be protected against erosion by chutes, drop structures, pipe drops, other suitable structures or grassed waterway, or specially graded channel entrances where surface water or shallow ditches enter deeper ditches.

Grade control structures, bank protection, or other suitable measures shall be used if necessary to reduce velocities and control erosion.

Culverts and bridges shall have enough hydraulic capacity and depth for drainage needs and to minimize obstruction to flow. The following capacities shall apply:

- Farm Field Crossings - Design discharge where overbank flow will not cause erosion when water reenters the channel.
- Private Drives - 2-year, 24-hour duration storm frequency.
- Town, County and Rural Roads - 10-year, 24-hour duration storm frequency or local government requirements.
- State Highways - As determined by the Wisconsin Department of Transportation.

Capacities of pipe or drop structures generally shall be determined by use of the applicable drainage coefficients with the "island-type" of construction used to protect the structure from washout. Structures used to lower water into mains or laterals shall be designed in accordance with NRCS FOTG Standard 410, Grade Stabilization Structure.

Each structure for an open ditch system shall be designed according to NRCS FOTG standards

for the kind of structure and type of construction used.

Recessed ramps shall be provided where necessary for watering stock. The ramp shall be constructed on a 6:1 or flatter slope. Surfacing as needed to prevent erosion and to allow stable footing shall be provided.

K. Crossings

Cattle or machinery crossings shall meet the criteria in NRCS FOTG Standard 578, Stream Crossing.

L. Channel Vegetation

Vegetation shall be established according to NRCS FOTG Standard 342, Critical Area Seeding.

Seeding is required on all ditches. Side slopes and berms shall be seeded. If there is no spoil bank, the seeding should extend a minimum of one rod from the top of the ditch bank. In pasture areas, all disturbed areas should be seeded.

VI. Considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice but are not required to ensure its basic conservation functions are as follows.

A. Effects on the detachment and transport of sediment and chemicals and dissolved and sediment-attached substances into watercourses.

B. Effects on wetlands or water-related wildlife habitat.

C. Potential for changes in downstream water temperature.

VII. Plans and Specifications

Plans and specifications for constructing surface drainage mains or laterals shall be in keeping with this standard and shall describe the requirements for constructing the practice to achieve its intended purpose.

VIII. Operation and Maintenance

An Operation and Maintenance Plan shall be developed with the landowner or operator that is consistent with the purposes of this practice, intended life of the components, and criteria for design.

IX. References

USDA, NRCS Wisconsin Field Office Technical Guide, Section IV, Conservation Practice Standards and Specifications.

USDA, NRCS National Engineering Handbook, Part 650, Engineering Field Handbook.

USDA, NRCS Drainage Guide for Wisconsin.

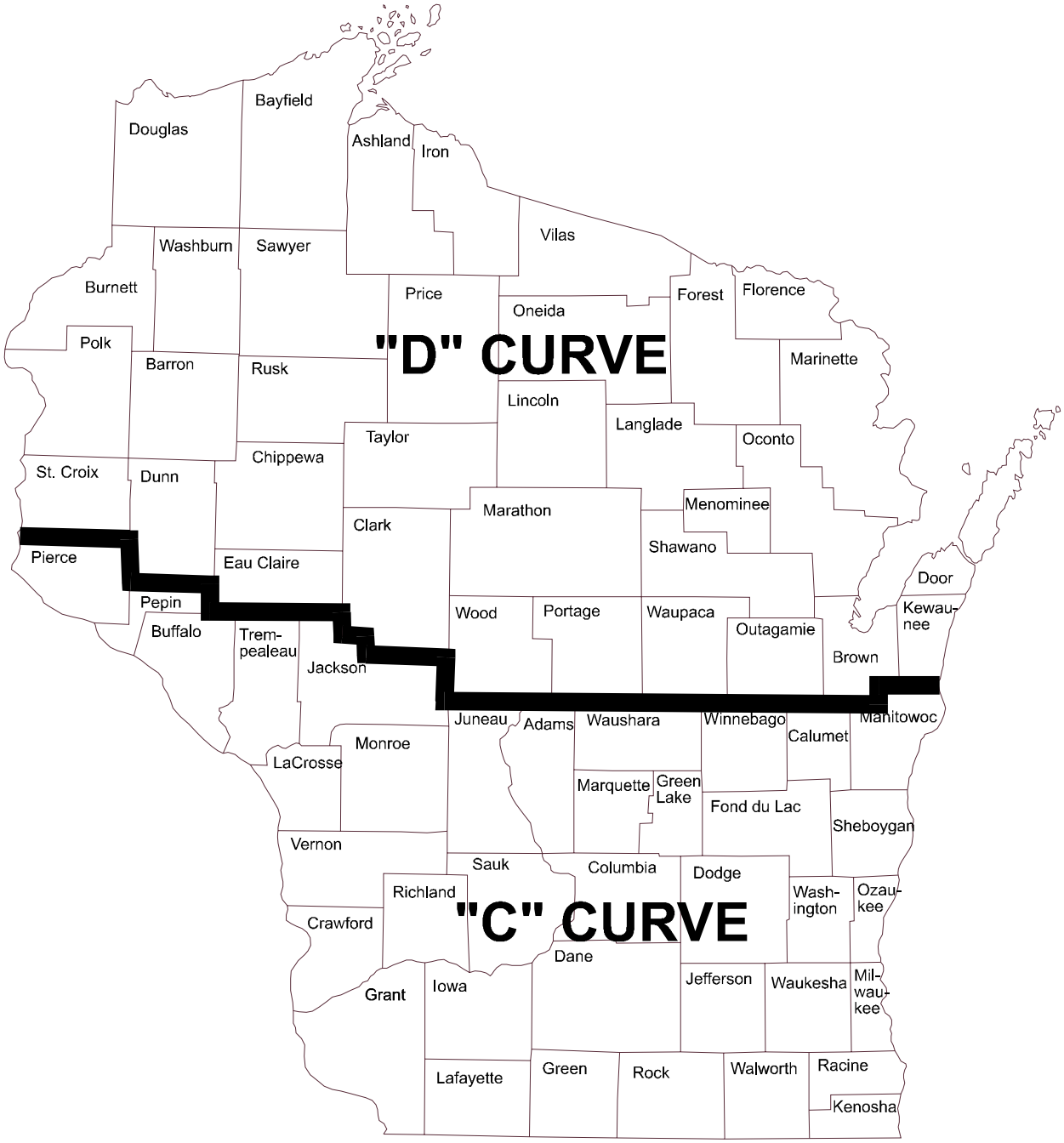

Figure 1

Wisconsin map showing applicable drainage curves for watersheds having an average slope of less than 25 feet per mile.